REMARKS

In a final Office Action dated September 26, 2008, the Examiner rejected claims 6-9 and 20-26 under 35 U.S.C. §102(e) as anticipated by Buyya et al., "A Deadline and Budget Constrained Cost-Time Optimisation Algorithm for Scheduling Task Farming Applications on Global Grids" (herein *Buyya*).[1]

Applicants have corrected a minor typographical error in claim 20.

Except for the correction of the typographical error in claim 20, the claims are unamended. Applicants respectfully traverse the prior art rejections herein.

As explained previously, applicants' invention relates to the scheduling of computer resources in an environment where at least some of the resources are fee-based. The exemplary embodiment involves a fee-based distributed computing system (grid system), in which computing resource can be purchased on demand. The fees for purchasing resource could vary by time of day and/or day of week, or according to how busy the system is or other factors. A local computer system or network, such as an in-house computer system within an enterprise, might provide a limited amount of processing capability and be connected to the fee-based computing system for additional computing capacity. Other variations of this exemplary embodiment are possible.

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[1] Page 2 of the Office Action rejects claims 6, 7 and 20-26 on these grounds. However, claims 8 and 9 are mentioned in the rejection at p. 5 and 6 of the Office Action, without stating any other grounds of rejection for these claims. Therefore applicants understand the anticipation rejection citing *Buyya* to apply to all pending claims, and the omission of claims 8 and 9 from explicit mention on p. 2 of the Office Action to be an inadvertent error.

In such an environment, it is possible to simply purchase additional computing resources from the fee-based system whenever there is a job in need (i.e., demand which can not be met by the available in-house or other free resources, to the extent there are any). However, this involves additional cost, when by waiting it might have been possible to execute the same job using available in-house or other free resources, or to execute the same job at a lower cost from the fee-based system. At the same time, if execution is deferred whenever a fee is involved, or whenever a fee in excess of a standard rate is exceeded, it is possible that some high-priority jobs will be deferred and cause unwanted consequences in excess of the fee that would otherwise have been charged.

Applicants recognize that not all jobs are equal. For each job, there is some theoretical corresponding value associated with having it done now as opposed to later. Applicants therefore define a corresponding valuation for each job to the computer system, and to compare these valuations to the projected fee for processing the job now. If the fee exceeds the value, the job is deferred; if not, the job is scheduled for processing, and the resultant fee is incurred. This valuation is specific to the job, it being expected that the valuations will vary. Variation in valuation may cause some jobs to be deferred, while other more valuable jobs are allocated the fee-based resources necessary for execution now, notwithstanding the additional fee involved. By deferring less "valuable" jobs, greater flexibility is achieved to process these jobs at a time when the fees are lower, or when in-house computing resources are idle so that no fee is required.

Therefore a significant feature of applicants' invention is that ***a respective valuation*** is associated with each of a plurality of work items, and that this ***valuation is compared to a respective cost*** of the computing resources required to do the work, the scheduler managing access to the resources based on this comparison. Applicants' representative claim 6 recites:

6. A computer-implemented method for managing access to computer resources, the method comprising:

defining a respective valuation of each of a plurality of work items to be processed by one or more data processing systems;

comparing the respective valuation of each respective said work item to a respective cost of accessing additional computer resources necessary to process the work item; and

dynamically managing the access of additional computer resources by respective ones of the work items *if the respective valuation of each of the work items exceeds the respective cost* of accessing additional computer resources necessary to process corresponding ones of the work items. [emphasis added]

Independent claims 20 and 23 vary in scope, but all contain limitations analogous to the italicized limitations above.

Buyya discloses a job scheduling mechanism for use in a scheduling jobs to execute in a fee-based distributed computing environment. A resource broker acts as an intermediary between a user having multiple jobs requiring execution and distributed computer resources capable of processing the jobs. The resource broker discovers the availability and cost of computing resources from diverse sources, and schedules the jobs for execution on one or more computing resources in such as way as to optimize both cost and time of completion. *Buyya* discloses that a user can specify an overall budget and deadline for multiple jobs. The resource broker schedules jobs on the available resources to complete within the overall deadline at lowest possible cost, not to exceed the budget.

Buyya's algorithm for scheduling jobs to available resources repeats a series of steps to assign a job to an available resource, as long as there exist unprocessed jobs and the current time and processing expenses are within the deadline and budget limits. I.e., the algorithm chooses a resource, from among multiple possible candidates, until all jobs are processed, or the budget or time limits are exceeded. This algorithm takes into account the job consumption rate of each

resource and cost of the resource, projects the completion time taking into account other jobs, and preferentially assigns the job to the lowest cost resource which will complete within the completion time.

Significantly, although *Buyya* does disclose an overall "budget", *Buyya*'s scheduler will terminate if the overall budget is exceeded, and the individual jobs do not have any sort of valuation associated with them. I.e., there is no disclosure in *Buyya* of a step of "defining ***a respective valuation of each*** of a plurality of work items...", as recited in applicants' claims. In accordance with *Buyya*'s algorithm, each job is simply assigned to the lowest cost resource which will complete within the target time limit, and there is no discrimination in "valuation" between one job or another.

Buyya's "budget" is not a "respective valuation" which is associated with "each of a plurality" of work items, but an ultimate boundary on the process. Any process must operate within boundaries, whether explicitly stated or not. Any time a person or entity contracts for services with another, there is a limit, either express or implied, on the total amount of service to be supplied, i.e., on the total budget which the service provider is obligated to honor on behalf of the requesting entity. Even if no budget is explicitly stated in a service contract or other arrangement, the service provided is not expected to extend an *infinite* budget to the user, and therefore there is impliedly some finite limit to the budget. *Buyya* merely formally defines this finite limit on the extent of the scheduling process. If that finite limit is exceeded, the scheduler terminates.

Applicants' claims, on the other hand, recite a process wherein multiple "valuations" are defined, a separate one for each work item, and the respective valuation of the work item is compared to its respective cost. Buyya does not show any form of definition of multiple

"valuations", each for a respective work item. Even if Buyya's "budget" is considered a "valuation", there is one and only one valuation, and this valuation is only used for one purpose: to terminate the process if it gets out of bounds. Thus, the limitations of multiple valuations, each defined for a respective one of the work items, is not shown. For all the reasons stated above, the claims are not anticipated by *Buyya*.

Nor are the claims obvious over *Buyya*. At a high level, *Buyya* is scheduling resources of a fee-based system, similar to the general task being performed by applicants, but the method of doing so is substantially different. *Buyya* does not draw any valuation distinction among different jobs. It merely attempts to minimize cost of job completion within certain time constraints, and therefore follows a scheduling algorithm in which resources are sorted according to cost and job completion rate, and an appropriate resource is chosen. Thus, *Buyya*'s primary cost-saving vehicle is ***not distinguishing among different jobs, but distinguishing among different resources***. *Buyya* automatically evaluates various parameters of multiple resources in a distributed network, and chooses resources based on various factors to minimize cost. *Buyya*'s system is not about enforcing a budget, but about obtaining service at the lowest possible cost within a time constraint. A budget limit is provided as an overall boundary on the process, but is not otherwise used.

Applicant's system, on the other hand, recognizes the different "valuations" of different jobs, and is intended to reduce costs overall by deferring selective jobs when the valuation of the job is not sufficiently high to justify the current cost, since such jobs can likely be performed at lower cost during off-peak times. I.e., ***applicant's system achieves cost saving by distinguishing***

among different jobs, rather than different resources. This is essentially a different approach, and one which is not disclosed or rendered obvious by *Buyya*.[2]

For all the reasons stated above, the independent claims are patentable over the cited art.

Finally, applicants note that, even if *Buyya*'s budget is considered a "respective valuation of each of a plurality of work items", a proposition which applicants do not concede, certain dependent claims recite further and additional limitations not shown in *Buyya*. Specifically, claims 8, 22 and 25 recite applying a priority algorithm to prevent starvation of work items which are delayed, so that all work times are completed. If, as seems to be the case, the Examiner is reading *Buyya*'s "budget" as a "respective valuation", applicants point out that the consequence of exceeding the budget is that the scheduler terminates, and no further jobs are scheduled. Thus, rather than give the deferred jobs a priority to prevent starvation, *Buyya* shows that the deferred jobs are simply not performed at all. Clearly, this teaches away from the recited limitations of dependent claims 8, 22 and 25. Dependent claims 9, 23 and 26 contain these same limitations, and further recite that the priority algorithm increases the priority of the work items to complete prior to a cut-off date. Again, this feature is not shown in *Buyya*. *Buyya* does disclose a time constraint, but this time constraint affects the choice of resource ***before*** the budget is exceeded, and has no effect after exceeding the budget (which terminates *Buyya*'s scheduling process).

In view of the foregoing, applicants submit that the claims are now in condition for allowance and respectfully request reconsideration and allowance of all claims. In addition, the

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[2] Although the two techniques are different, they are not necessarily mutually exclusive, and it may be possible to combine both techniques in a scheduler which would take into account both the valuations of individual work items as claimed by applicants and the parameters of the resources as disclosed in *Buyya*. However, such a hypothetical device is not disclosed or suggested by *Buyya* alone.

Examiner is encouraged to contact applicants' attorney by telephone if there are outstanding issues left to be resolved to place this case in condition for allowance.

Respectfully submitted,

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